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ACTIVE SCORE CLUSTERING ALGORITHM FOR WSN TO ALLEVIATE NODE ENERGY CONSUMPTION

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ABSTRACT

Since the sensor and nodes present in the WSN have restricted energy resources, dragging out network lifetime and improving adaptability are fundamental components in energy-productive Wireless Sensor Networks (WSNs). Most existing methodologies consider the leftover residual energy of a node when the cluster head (CH) is chosen, precluding different variables related with that particular node, for example, its locale and its nodal degree inside the WSN geography. Subsequently, this paper proposes a new algorithm named Active Score Clustering Algorithm (ASCA) for WSNs to lessen the general energy utilization /consumption of the node, balance the energy utilization among all nodes/sensors and improve the overall network adaptability and versatility. This paper has inspected the performance of the proposed ASCA algorithm utilizing simulation tests with some of the best algorithms in this domain. The result and the outcomes exhibit that the ASCA algorithm out performed the existing algorithms by a good margin with respect to energy proficiency and versatility.

Keywords: Wireless Sensor Networks (WSN), ASCA algorithm, network

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1. INTRODUCTION

Due to the energy saving qualities and its suitability for high scalable wireless networks clustering provides the best solution to preserve the energy of the nodes in the wireless sensor network. Therefore the extending the lifetime of the nodes in a WSN is the primary aim for any designer who develops the WSN. To accomplish high energy-productivity and guarantee the long lifetime of the network, the sensor network can be divided into small partitioned sections.

The sensor nodes can be coordinated into clusters, where detected information is gathered and handled locally as self-sufficient clusters prior to being shipped off the BS (base station).

In numerous sensor network applications where the lifetime is pivotal, the various leveled system has all the earmarks of being a promising plan for effectively sorting out the network. In any case, unequal energy consumption and utilization among clusters is as still an issue that has to be addressed, and it is firmly bound with the correct selection of the CH(Cluster Head) nodes inside the network [1][2][3].

The clustering is a popular research area mainly due to its versatile and numerous applications and in wireless sensor network many research scholars has implemented clustering for plethora of purpose but many areas in the WSN is yet to be addressed and the difficulty in selecting the optimum cluster head is a major problem.

2. PROBLEM STATEMEMT

The WSN cannot be treated as an orthodox network mainly due to its complex design and the challenges present in the sensor while selecting the cluster head and securing the data to the sink. The most important design parameter is energy consumption of the nodes present in the network [4]. Hence a proper foolproof design and development of the new algorithm is imperative. Most of the existing algorithms and approaches employs random node as the cluster head using probability method and fuzzy method which proved to be costly. Few of the existing algorithms used residual node energy as the criteria to select the cluster head. The main problem here in such methods is the high energy nodes will be grouped or concentrated in a particular location alone in the network. The methods used in HEED and LCP are considered where the high energy nodes are considered as the cluster head and these methods are compared with the proposed ASCA algorithm. The figure 1 shows the cluster head selection using random deployment of the nodes using the high energy values.

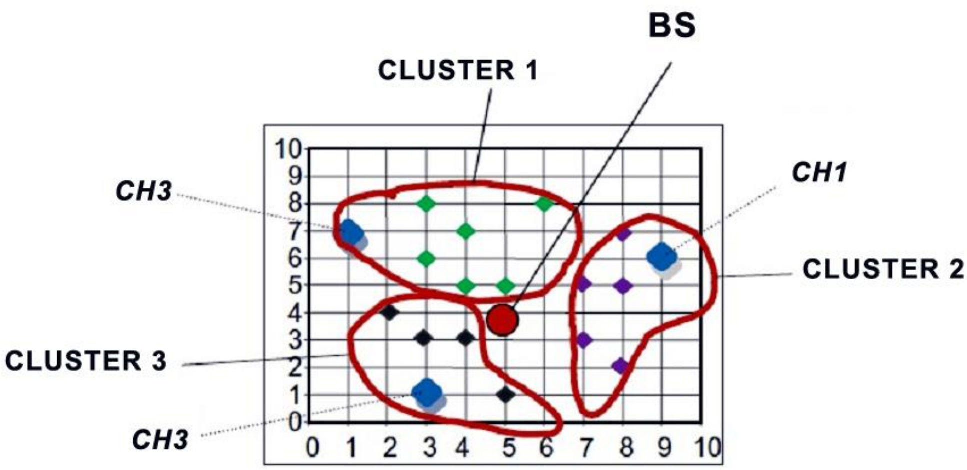

Figure 1 Cluster head selection using random mechanism

From the figure 1, it is quite evident that the CH1, CH2, and CH3 are the nodes with high energy and that’s why they are selected as the cluster heads. In cluster 1, the node 1 will be the cluster head and it will send the data aggregation to the base station BS and therefore draining its energy very fast. This is one of the major problems in the existing algorithms. The next major problem is the distance of the cluster head from the base station. When the distance is higher the energy required to transmit the data will be higher and this will drain the energy of the CH quickly.

3. PROPOSED APPROACH

To overcome the aforementioned snags and limitations the proposed algorithm ASCA is presented and the most important feature of the proposed ASCA algorithm is,

Distributed algorithm – This is one of the best features that is proposed as the selection of the cluster head does not need any involvement from the base station or any end user utilizing the network.

No minimum criteria for CH – The next important feature of the proposed ASCA is that there are no minimum requirement such as energy levels or values for the nodes to be selected as a cluster head.

The proposed ASCA is comprised of many steps, they are,

- Initialization of the nodes
- Cluster Head election process
- Final cluster head selection
- The communication between clusters

After the initialization of the nodes in the network, the election process to select the cluster head takes place as in the other existing algorithms like LEACH and HEED. The main difference here in the proposed ASCA is that the node using the local information inside the cluster will decide whether that node can become the cluster head or not. The local data or information here is the distance between the node and the base station, number of neighboring nodes available, and the amount of energy left in the node. These parameters are called the node score. Based on this individual node score, the cluster head will be selected.

The final selection is done by the nodes as each node will send its node score to its neighboring nodes and the node with the highest score will be selected as the CH cluster head. The node that is selected finally as the CH will broadcast their ID along with the flag named "CH=true" to the other nodes present in the network.

The Initialization Algorithm

```
Initialization algorithm
∀ node n in N do begin
Find the neighboring nodes →Nn
Compute the Node energy  → Ne
Compute the distance from base station →Nd
S=Nn +Ne +Nd// Node Score
Broadcast (ID, S)
End For
```

Figure 2 Pseudo code of initialization algorithm

The figure 2 shows the initialization algorithm where all the nodes are fetched and the number of neighboring nodes is computed initially. Then the node energy or the energy left in the node is computed. Once the energy computation is over, the distance between the node and the BS is calculated. All these values are added to form the node score and depending upon this score the cluster head will be selected or rather the candidate for the cluster head is found. The candidate will transmit a hello message with the ID and the node score to its neighboring nodes in the cluster.

The Election Procedure

```
CH candidate election algorithm
∀ node n in N do begin
IF node score (i) > node score (j) & node within the threshold level
CH candidate = TRUE
Complete broadcast
Else
Sleep_Mode=TRUE
END IF
End For
```

Figure 3 Pseudo code of the cluster head candidate election process

The figure 3 showcases the election process of the cluster head candidate selection and here the individual node scores of the nodes present in a cluster is compared with the other node score and if the value greater and higher than the threshold value provided, that particular node is considered as a candidate for the cluster head. The node that satisfies the minimum criteria will pronounce themselves as a candidate to the other nodes in the cluster. Now the CH candidates will broadcast a complete message with their respective ID. The other nodes fails in the race will enter into the SLEEP mode until the next election process is initiated.

Candidate Finalization Process

Once the node receives the complete message, the finalization of the cluster head process starts. Here the radius of the node or the radius of the transmission range plays a pivotal role in finalizing the cluster head. So each and every candidate node present in the cluster will its diameter using the radius function and if the criteria satisfies, the final cluster head CH will be found. The pseudo code is shown in the figure 4.

```
CH Finalization algorithm
MSG← COMPLETE message from candidate CH
IF(diameter (i) <node(i).radius OR diameter(j)<node(j),radius)
ADD sensor Si to Sj
End IF
While(CHcandidate=TRUE) do begin
IF ( node score(i) > node score(j))
IsCH candidate = TRUE
BROADCAST – CH(ID,msg)
EXIT
Else
CHcandidate= FALSE
End If
End While
```

Figure 4 Pseudo code to finalize the CH in a cluster

Evaluation Metrics Used

The proposed ASCA algorithm is tested with simulation tools due to time, cost and complexity in building a physical sensor network. The OMNet++ [8] is used as the simulator tool as it

support dynamic mobility, radio model wireless channel and most importantly it supports most of the wireless sensor applications and the simulation results are very accurate than other simulator tools.

The main objective of this paper is to design a new algorithm and test it in simulation tools to prove its capabilities as the simulation scenario is quite similar to that of the real life scenario. The metric used are PRR – Packet Reception Rate and PRP – Packet Reception Probability. At the same time, the energy consumption is also tracked and compared with other approaches. The lifetime of the network is also used as a metric evaluation along with the reliability of the network.

4. EXPERIMENTAL RESULTS

To witness the performance of the proposed ASCA algorithm, the experimental results are compared with HEED [5] and LCP [6] algorithms. The simulation parameters used in the simulator tool is shown in the table 1.

4.1. Overhead Based on Control Messages

The control messages that are broadcasted during the setup will consume energy unnecessarily and the figure 5 showcases the control message overhead of the proposed algorithm and the compared HEED and LCP algorithms. From the experimental results it is clear that the proposed ASCA produces minimum control messages and this will reduce the energy consumption of the sensors. Number of nodes used in the experiment is varied from 200 to 600 in an area of 150 x 150 meters.

Table 1 Simulation parameters used in the experiment

Parameter	Value
Deployment domain	150 m x 150 m
Deployment method	Uniform, random
Simulation time per second	500–1100
Deployed nodes	200, 250, 300, 350, 400, 450, 500
Initial energy	25 J
Nodes status	Stationary
Application	Throughput test
Base Station location	Central
Communication radio type	CC2420
Radio carrier frequency	2.4 GHz
MAC protocols	T-MAC

From the figure it is quite evident that the proposed ASCA algorithm produces the least amount of control messages since the nodes that are not in the race for the election will enter into sleep mode and there by unnecessary messages are not transmitted to the BS. When the number of nodes increases the control messages also increased steeply in the LCP algorithm.

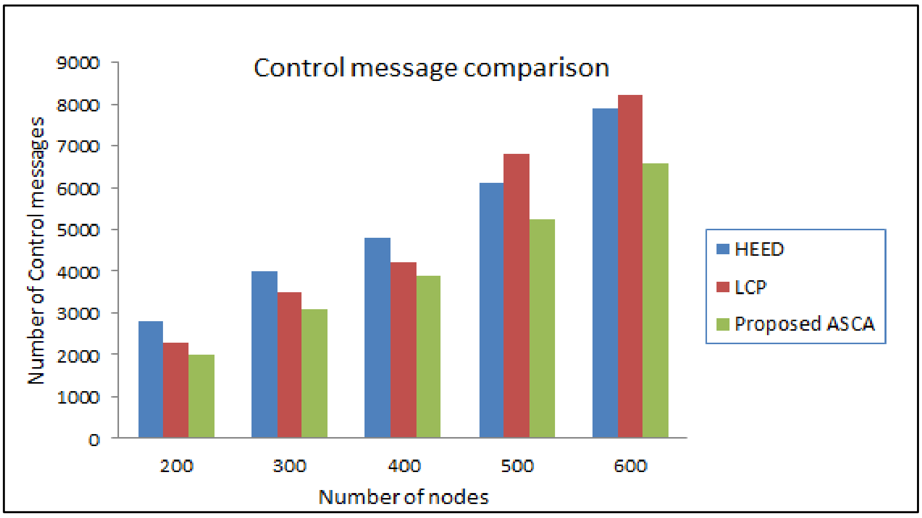

Figure 5 Control message overhead comparison

4.2. Energy Consumption

Totally 200 nodes are selected in the simulation scenario and from the figure 6, it is quite clear that the proposed ASCA algorithm is more efficient and network lasted for a longer time and a detailed comparison is carried out. The ASCA algorithm extended the lifetime of the network by a good margin (i.e.) 8 % more life time than LCP and 17.6% more life time than HEED algorithm. The sensors present in the HEED died at almost after 1200 rounds and the sensors present in the LCP died after 1450 rounds and the proposed ASCA died after 1500 rounds.

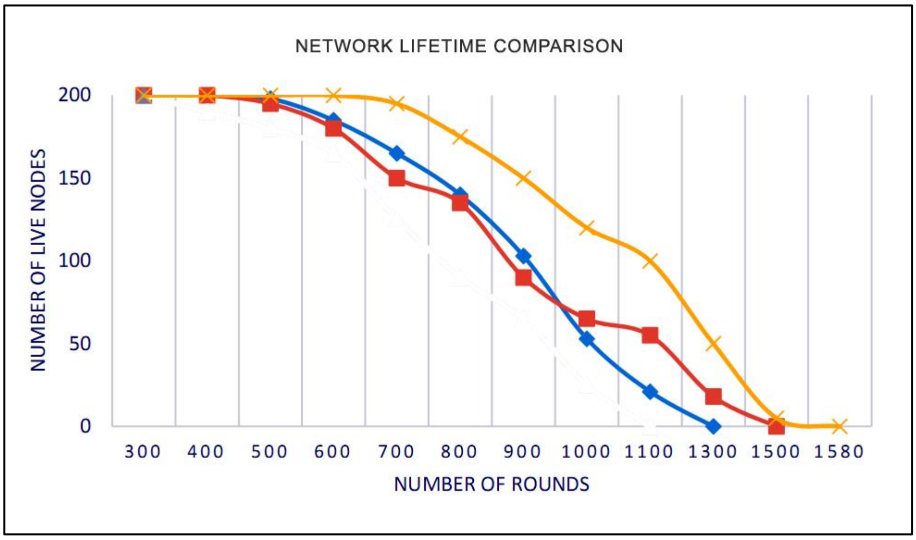

Figure 6 Network lifetime comparison

The life span of a network is usually examined by some metrics that are specially meant for life time namely, First Node to Die - FND, Half Node to Die – HND and Last Node to Die – LND. The number of nodes during the experiment is varied from 200 to 600 and the proposed ASCA algorithm fared reasonably well when the node size is 200 and 300 and beyond that all the algorithms performed similarly.

But HND comparison proved that the proposed ASCA algorithm performed superbly when the node size is increased and completely outscored the other two algorithms compared. Both these comparisons are shown in the figure 7 and in figure 8 where the proposed ASCA algorithm improved the overall lifetime span of the network to a great extent.

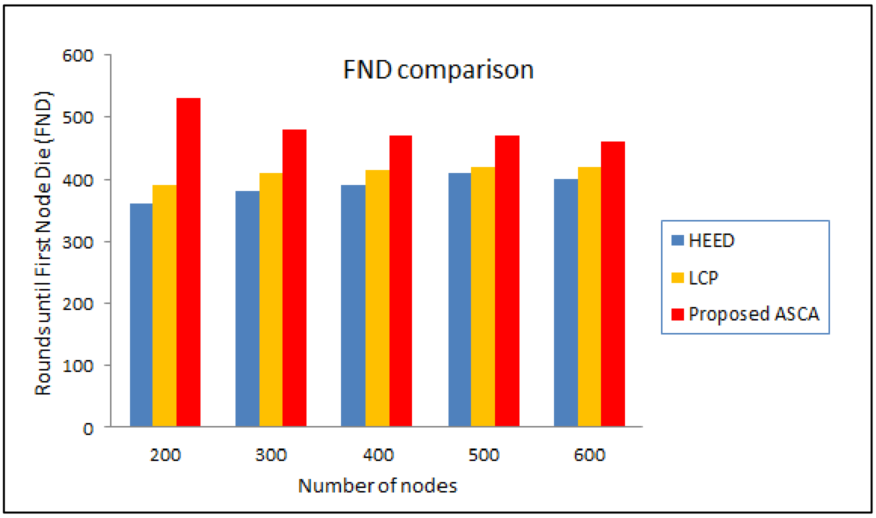

Figure 7 FND comparison for varying network size

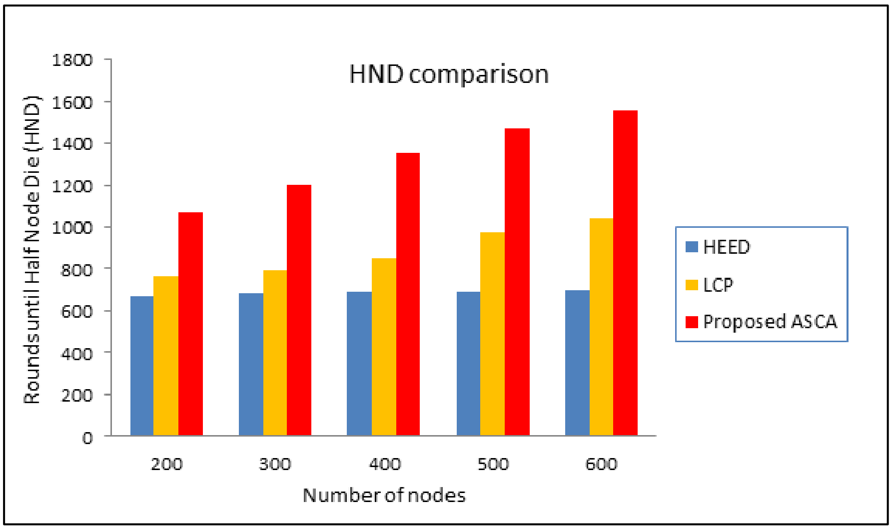

Figure 8 HND comparison for varying network size

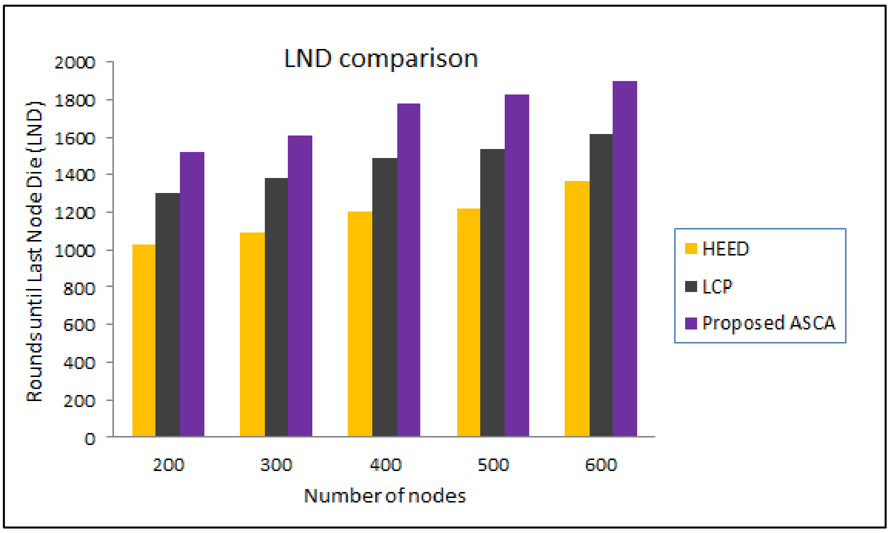

Figure 9 LND comparison for varying network size

At last the LND is also compared and the results showcased that the proposed along with The LCP algorithm performances increased with the increase in the network size and the

proposed approach proved to the very efficient with respect to energy conservation and consumption. The LND comparison is shown in the figure 9.

4.3. Reliability Metric

The reliability and the trust of the node is measured by the number of packet received by the base station [7] from the nodes and this comparison is made in the following graph and it is evident that the proposed ASCA algorithm outscored the other two existing methods by a good margin. The comparison graph is shown in the figure 10.

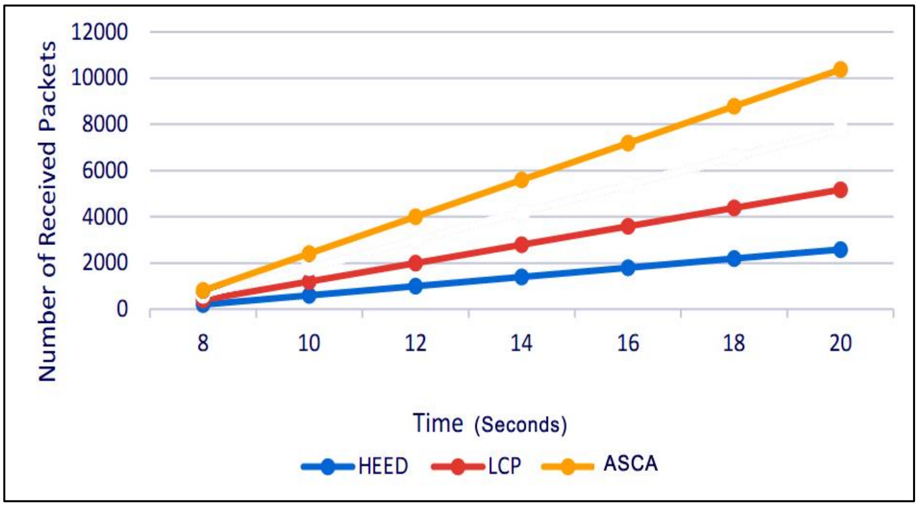

Figure 10 Number of packets received by the BS

5. CONCLUSION

The new energy saving efficient algorithm ASCA presented in this paper with an objective to decrease the overall energy consumption of the nodes, increase the life time of the network and to increase the reliability of the data that are being transmitted is achieved as the experimental results proved that the ASCA performed extremely well with respect to efficiency in saving energy and reliability in transmitting the data to the base station. The proposed algorithm proved to offer a better load balancing and in future the ASCA algorithm can be upgraded to operate in multi-hop manner in extreme environments.

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